

# R6 Project Information Crosswalk

## Contents

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## Evaluate Information about the Geologic Setting of the Proposed GS Site

40 CFR 146.82(a)(2),(3),(5), and (6)

This crosswalk includes information from the Title 40 Code of Federal Regulations (CFR) and generally follows the layout of the narrative templates and Sequestration Guidance documents from the Geologic Sequestration Data Tool (GSDT) available on EPA's national UIC program website.

This Crosswalk includes information from the Title 40 Code of Federal Regulations (CFR) and generally follows the layout of the Geologic Sequestration Data Tool (GSDT) and narrative templates, with additional information pulled from the Sequestration Guidance documents available on EPA's national UIC program website.

If you have uploaded a file to the GSDT the name will be captured in the system, as will all the filled-in or selected options. They can be downloaded by the permit reviewers as pdfs.

### Clarifications

In the GSDT the term facility has proven to be confusing when compared to the regulations, partly because they were written to encompass the entire universe of the UIC program. The term "facility" has multiple meanings and is dependent on the scope of the UIC project. If the project has a single well, the facility is the well, if the project has multiple wells, the facility is the larger operation.

In other UIC guidance, it is stated that the facility name should be the official or legal name of the facility (which might not necessarily be the project name). It looks like the intent of these regulations is to make it possible to easily find the injection location. The facility mailing address should probably be the physical address of the operation, or P.O. Box where a physical address does not exist.

For a Facility with multiple well locations, the latitude longitude of the entrance drive to the facility where they are located would be helpful.

### Narratives

Narratives cover the range of information desired and leave the final organization to the applicant's preference. The Crosswalk does not replace the Template but may add items to consider. Where there are similar questions repeated in different sections of the Template, the Crosswalk attempts to put those in a preliminary discussion at the front of the document in a generic format (i.e. each subsection will have a slightly different focus to reduce repetition).

### Documents

To keep document size manageable and provide all the information in a usable format, it would be useful to create a separate file or files for the different types of information. If the GSDT upload option does not allow multiple files or overwrites the first one, zip the files together prior to uploading.

### Referencing Other Submissions

Note that a number of discussions are included under multiple headings and different modules. To avoid errors and duplication, please do NOT submit the detailed information twice. Include

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the appropriate synthesis in the section discusses and reference materials submitted as part of the permit application, via the AoR delineation modeling input advisor, etc., but references should be specific (e.g., "Computational modeling results - see permit application Section 1, pages 2 through 5 and Figures 1.7 through 1.12, as submitted 1/1/14."). Referenced materials should explicitly address the selected requirements. If using an uploaded file, include the file name as well. (Note: the GSDT incorporates this information in its output.)

## Formatting and Other Data Expectations

See the separate most recent *R6 Class 6 Geological Documentation.docx*.

## Repetitive Information Requests

### Field Data Collection or Testing Reporting

Narratives leave the organization to the applicant. One option, that may keep documents sized manageable is to provide the detailed data collection information in a separate file or files for the different collection efforts. Wherever it is located the type of information needed follows this generic outline.

1. Location of Data on map and in a data table
  - a. Specific surface location
  - b. Depth(s), formation(s)
2. Date and Time of Collection
  - a. Description of site conditions
3. Methodology used to collect it; (QAPP)
  - a. Sampling equipment, be specific
  - b. Field procedures
  - c. Type of operation: measurements, samples, logging, testing
    - i. Test or other parameters collected
4. Compilation of field data collected
  - a. Physical description.
  - b. Additional analysis – if under laboratory section as well
  - c. Any issues with sample procurement, e.g., disintegration of poor-quality rocks during transport or sample retrieval
5. Results in tabular and graphical form for the formation, confining or injection zones
6. Summary statistics on data and any statistical representations (e.g., variograms); and
7. Discuss results, including data quality and sources of uncertainty.
8. Extrapolations for CO<sub>2</sub>

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### Laboratory Analysis Reporting

Narratives leave the organization to the applicant. One option, that may keep documents sized manageable is to provide the detailed data on laboratory analysis or special tests in a separate file or files for the different collection efforts. Wherever it is located the type of information needed follows this generic outline.

1. Location of Data on map and in a data table (may refer back to collection information)
  - a. Specific surface location
  - b. Depth(s), formation(s)
2. Date and Time of Collection (may refer back to collection information)
3. Method(s) used for Laboratory analysis
  - a. justification for selection of method(s),
  - b. associated assumptions, and
  - c. a description of experimental conditions;
4. QA verification and procedures
5. Compilation of laboratory analysis
  - a. Physical description (if different from field collection)
  - b. Existence of discontinuities (fractures, fossils, etc.) in tested samples
6. Results in tabular and graphical form for the formation, confining or injection zones
7. Summary statistics on data and any statistical representations (e.g., variograms); and
8. Discuss results, including data quality and sources of uncertainty.
9. Extrapolations for CO<sub>2</sub>
10. Comparison of data from different tests if more than one type of test is used for a particular parameter;

### Test Analysis

1. Location of Data on map and in a data table (may refer back to collection information)
  - a. Specific surface location
  - b. Depth(s), formation(s)
2. Date and Time of Collection (may refer back to collection information)
3. Method(s) used for Test analysis
  - a. justification for selection of method(s),
  - b. associated assumptions, and
  - c. description of applicable conditions;
4. Data verification and clean-up
5. Analysis techniques

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- a. Calculations and ramifications thereof
- b. Outliers and manipulations
- 6. Compilation of analytical results
  - a. Output parameters and/or projections
  - b. Identification of discontinuities (fractures, faults, barriers, or other changes)
- 7. Results in tabular and graphical form (semi-log, log-log, etc.) for the formation, confining or injection zones
- 8. Summary statistics on data and any statistical representations (e.g., variograms); and
- 9. Discuss results, including data quality and sources of uncertainty.
- 10. Extrapolations for CO<sub>2</sub>

Comparison of data from different tests if more than one type of test is used for a particular parameter;

## Project Information Crosswalk

Green tabs indicate GSDT Heading or Narrative within GSDT

Table [ SEQ Table \\* ARABIC ]: General Information (tab)

Information	CFR and Guidance	Location & File: GSDT or CBI?
Number of proposed Class VI wells		
Brief description of the project		
Describe all activities conducted by the applicant that require permits under the following programs: Fill-ins		
1. Resource Conservation and Recovery Act (RCRA): Description	40 CFR 261.4(h)	
2. Underground Injection Control Program (UIC) under Safe Drinking Water Act (SDWA): Description		
3. National Pollutant Discharge Elimination System (NPDES) under Clean Water Act (CWA): Description		
4. Proposed injection mass/volume & CO2 source: Description		
List all permits, or construction approvals received or applied for under the following programs: (fill in)		
1. Hazardous Waste Management program under RCRA: Permit ID(s)	Class VI Implementation Manual for UIC Directors	
2. UIC program under SDWA: Permit ID(s)		
3. NPDES program under CWA: Permit ID(s)		
4. PSD program under CAA: Permit ID(s)		
5. Nonattainment program under CAA: Permit ID(s)		
6. National Emissions Standards for Hazardous Pollutants (NESHAPS) preconstruction approval under CAA: Permit ID(s)		
7. Ocean dumping permits under Marine Protection Research and Sanctuaries Act (MPRSA): Permit ID(s)		
8. Dredge and fill permits under section 404 of the CWA: Permit ID(s)		
9. Other relevant environmental permits, including state permits: Permit Type(s) and ID(s)		

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Table [ SEQ Table \\* ARABIC ]: Facility and Owner/Operator Information (tab)

Information	CFR and Guidance	Location & File: GSDT or CBI?
2.1. Facility/site for which application is submitted		
1. Name (Surface Location company name), address, location (Lat, Long) at entrance to property;	40 CFR 144.31 (e)	
2. Up to four Standard Industrial Classification (SIC) codes for the facility;		
3. Facility located on Indian lands (Y or N): Give tribal names		
2.2. Facility Contact Information		
Name, phone, email		
2.4. Operator Information		
Name, business address, business phone number; Operator status (Federal, State, Private, Other)		
2.5. Ownership status		
Owner, Not Owner; Owner's name, business address & phone number		

Initial Permit Application: Site Characterization (tab)

40 CFR 146.82(a)(2),(3),(4),(5), & (6); LAC §3607.C.1 through 3607.C.2

40 CFR 146.82(c)

Class VI Well Geologic Site Characterization Guidance: 2.1, 2.3.1, and 2.3.10; Guidance 4

Table [ SEQ Table \\* ARABIC ]: Class VI Application Narrative: Project Background Information

Information	CFR and Guidance	Location & File: GSDT or CBI?
1. Project Goals	40 CFR 146.82(a);	
2. Partners/collaborators	LAC <sup>1</sup> §3607.A	
3. Overview of the project timeframe		
4. Proposed injection mass/volume & CO2 source		
5. Whether an injection depth waiver or aquifer exemption expansion is being requested.		
6. List of state, tribe and territories; contacts		
7. Checkbox requesting Required project and facility details		

<sup>1</sup> LAC 43:XVII.Chapter 36

# Site Characterization Geoscience Narrative

Table [ SEQ Table \\* ARABIC ]: Class VI Application Narrative: Regional Geology

Information	CFR and Guidance	Location & File: GSDT or CBI?
REGIONAL GEOLOGY (20 to 50-mile radius around AoR)	40 CFR 146.82(a)(3); LAC §3607.C.1.b through 3607.C.1.c 30 TAC §331.121(c) & §331.121(a)(2)(D) & (F)	
1. Clearly written and complete summary of the topic.		
2. Regional maps and cross-sections constructed with well logs and to scale showing major aquifers, stratigraphic units, general lithology, confining zone(s) and the injection zone. (both figures and full-sized zipped attachments)	Guidance (Regional) 2.1, 2.3.1, and 2.3.10	
3. Regional stratigraphy, including a stratigraphic column.		
4. Regional hydrostratigraphy, emphasizing major aquifers and the lowest Underground Source of Drinking Water (USDW);		
5. Definition and description of Confining Zone(s) with regional structural and isopach maps.	40CFR §146.81(d)	
6. Definition and description of Injection Zone, including regional structural and isopach maps. (Is there sufficient permeability, porosity, and thickness to contain the fluid safely; Is the trap structural or stratigraphic)		
7. Regional cross-sections from the surface through the confining strata below the injection zone; or if a major structure exists below the injection zone, to as deep as necessary to define the structure;		
8. Discussion of the regional structural geology as it relates to the injection well site.		
9. Include fault characteristics and trends as they pertain to the confining and injection zones;		
a. Are faults active? Do they appear to stop at unconformities? Have they reversed offset over time?		
10. Discussion of regional groundwater flow in the injection zone.		

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Information	CFR and Guidance	Location & File: GSDT or CBI?
11. Describe all pressure sources, sinks or other critical activities in the confining or injection zones of the region.		

Table [ SEQ Table \\* ARABIC ]: Class VI Application Narrative: Hydrostratigraphy (USDWs)

Information	CFR and Guidance	Location & File: GSDT or CBI?
HYDROSTRATIGRAPHY (USDWS)	40 CFR 146.82(a)(5); 40 CFR 146.87(e), required at 146.82(c)(7)	
1. Detailed Hydrostratigraphy		
a. Major and minor aquifers and USDWs; provide depths/thicknesses, lithologies	LAC §3607.C.1.b.iv; §3617.B.5, required at §3619.A.7	
b. Vertical and lateral limits of USDWs, including separation from the injection formation.	Guidance: 2.3.8 & 4.5	
c. Direction of water movement in each USDW; data on hydraulic conductivity, hydraulic gradient, or porosity		
2. Are any of the aquifers currently serving as a source of drinking water?		
a. Discuss any fields surveys or data searches in the proposed location of the well(s)		
b. Provide the location of water wells and springs within the AoR. Provide the water well yield and number of people supplied. (May be CBI)	40 CFR 144.31(e)(7)	
3. Delineation of aquifer for which a <b>depth waiver</b> is sought; cross-sections need to cover all relevant layers down to at least the first USDW below the lower confining zone.		
4. Delineation of aquifer for which <b>exempt status</b> is sought		
5. Lowest USDW		
a. Description, including lithology, mineralogy, and rock properties		
b. Configuration of base of USDW including method of determination: Include open hole logs, cross-		

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Information	CFR and Guidance	Location & File: GSDT or CBI?
sections, equations and computations and publications that are relied upon.		

Table [ SEQ Table \\* ARABIC ]: Class VI Application Narrative: Seismic History

Information	CFR and Guidance	Location & File: GSDT or CBI?
SEISMIC HISTORY	40 CFR 146.82(a)(3)(v); LAC §3607.C.2.c Guidance: 2.3.7	
1. Regional seismic activity (earthquakes - natural and artificial)		
2. Tabulate and/or map seismic stations and their deployment history for each source pulled.		
3. Tabulate seismic events, their hypocenters, and magnitudes for as far back as data are available;		
4. Information on any seismic risk models used and the results; and		
5. A discussion of the degree of seismic risk in the region and information to support a determination that the confining system and wells at the project site are not vulnerable to damage from seismic activity.		
6. Provide a risk assessment of induced seismicity due to injection activities based on a known induced seismicity formula; This will be used to develop the Emergency and Remedial Response Plan.		

Table [ SEQ Table \\* ARABIC ]: Class VI Application Narrative: Local Geology

Information	CFR and Guidance	Location & File: GSDT or CBI?
LOCAL GEOLOGY		
1. Clearly written and complete summary of the topic, including aquifers and aquicludes. (Hydrology may be in a different section.)		
a. Maps covering AOR, the cone of influence, maximum possible extent of the composite plume and pressure migration or larger to accurately		

Information	CFR and Guidance	Location & File: GSDT or CBI?
<p>portray the geology with wells/APs keyed to tables.</p> <p>b. Include type logs for all key intervals. (If detailed description of the confining and injection zones is covered later, include the location.)</p> <p>c. Cross-sections and figures constructed with well logs and to scale. (zipped attachment)</p> <p>d. All AP/Well locations, major aquifers, USDW base, stratigraphic units, general lithology, confining zones, injection zone and injection interval shown on all maps and cross-sections</p> <p>e. Provide a USGS topographical map (1:24000 scale) indicating the plant boundaries and surface and bottom hole well locations of all facility well(s) or Artificial Penetrations (AP).</p> <p>f. Provide a simple schematic with a scale or distances listed illustrating the plant boundary and surface and bottom hole well locations of all facility wells.</p> <p>g. Structural geology of the project site, including whether the proposed storage site will be bounded or influenced by a structural trap (e.g., faults or a dome).</p> <p>h. Seismic reflection data if lacking well control or has complicated geology.</p> <p>i. Information to depict faulting. (Reference section with additional details.)</p> <p>2. May use a commercial structure map(s) or cross-sections with the local geologic</p>	<p>40 CFR 146.82(a)(2); (3)(i); (3)(vi) &amp; (5); LAC §3607.C.1.b through 3607.C.1.c</p> <p>Guidance 2.3.1 &amp; 2.1, 2.2</p> <p>R6 director's discretion</p>	

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Information	CFR and Guidance	Location & File: GSDT or CBI?
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interpretation; discuss any anomalies between interpretations.

Commented [DN1]: Redundant?

- a. Clarify if any geologic features illustrated on the commercial map are relevant to the sequestration project. Discuss any alternate interpretations or uncertainties in the map features.
3. Stratigraphy/stratigraphic column; The formation names, lithologies, and depths of the injection formation(s), confining zone(s), and USDWs within the proposed AoR;

Table [ SEQ Table \\* ARABIC ]: Class VI Application Narrative: Confining Zone(s)

Information	CFR and Guidance	Location & File: GSDT or CBI?
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#### CONFINING ZONE(S)

1. Detailed description of the confining zones located above and below the injection zone, and any potential secondary confining zone.
  - a. Reference figures, logs, maps, cross-sections, geophysical surveys, publications, etc. as needed.
  - b. Discuss the petrology and mineralogy (lithologic, cementation minerals & dissolution features, mineralogic, petrologic, i.e. hand sample and microscopy) and where the data came from: formation; samples or cores, etc;
    - i. Location of the samples on a map; and
    - ii. depths of samples and the names of the formations sampled;
    - iii. Lithologies and descriptions (e.g., color, texture) from cores or hand samples;
    - iv. Mineralogic and petrologic descriptions obtained via

40 CFR §146.81(d); 40 CFR 146.82(a)(3)(iii)

LAC §3607.C.2.a

Guidance 2.3.3 - 2.3.5; 2.3.10; 3.1 - 3.2

Guidance: mineralogy 2.3.4; Facies 3.1

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Information	CFR and Guidance	Location & File: GSDT or CBI?
	microscopy (with approximate percentages of minerals);	
	v. Cementation minerals and dissolution features; and	
	vi. A preliminary discussion of geochemical reactions that may affect the storage, confinement, and/or overall performance of the project (see Section 2.3.9 for additional information on baseline geochemistry).	
	c. Discussion of structure and isopach/isochore maps; supported by available well logs and cores (also see Sections 4.1 and 4.2).	
	i. Discuss the structural dip and the conservative nature of either a constant or variable dip. (Ties into modeling)	
	ii. Discuss the thickness and whether the values are true stratigraphic depths or vertical measures of thickness.	
	iii. Isopach maps (contour maps showing equal values of true stratigraphic thickness)	
	iv. Isochore maps (contour maps showing equal values of true vertical thickness)	
	2. Compare the different sources of information and demonstrate the compatibility or areas of uncertainty. Provide a map showing the georeferenced locations of all survey data.	
	3. Justification of its capability to act as a confining layer.	
	4. Description of the confining strata beneath injection zone including lithology and rock properties.	

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Table [ SEQ Table \\* ARABIC ]: Class VI Application Narrative: Injection Zone

Information	CFR and Guidance	Location & File: GSDT or CBI?
INJECTION ZONE(S)		
<ol style="list-style-type: none"> <li>1. Detailed description of the injection zone(s). <ol style="list-style-type: none"> <li>a. Reference figures, logs, maps, cross-sections, geophysical surveys, publications, etc. as needed.</li> <li>b. Discuss the petrology and mineralogy (lithologic, cementation minerals &amp; dissolution features, mineralogic, petrologic, i.e. hand sample and microscopy) and where the data came from: formation; samples or cores, etc; <ol style="list-style-type: none"> <li>i. Location of the samples on a map; and</li> <li>ii. depths of samples and the names of the formations sampled;</li> <li>iii. Lithologies and descriptions (e.g., color, texture) from cores or hand samples;</li> <li>iv. Mineralogic and petrologic descriptions obtained via microscopy (with approximate percentages of minerals);</li> <li>v. Cementation minerals and dissolution features; and</li> <li>vi. A preliminary discussion of geochemical reactions that may affect the storage, confinement, and/or overall performance of the project (see Section 2.3.9 for additional information on baseline geochemistry).</li> </ol> </li> <li>c. Discussion of structure and isopach/isochore maps; supported by</li> </ol> </li> </ol>		

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Information	CFR and Guidance	Location & File: GSDT or CBI?
<p>available well logs and cores (also see Sections 4.1 and 4.2).</p> <ol style="list-style-type: none"> <li>Discuss the structural dip and the conservative nature of either a constant or variable dip. (Ties into modeling)</li> <li>Discuss the thickness and whether the values are true stratigraphic depths or vertical measures of thickness.</li> <li>Isopach maps (contour maps showing equal values of true stratigraphic thickness)</li> <li>Isochore maps (contour maps showing equal values of true vertical thickness)</li> </ol> <p>5. Compare the different sources of information and demonstrate the compatibility or areas of uncertainty. Provide a map showing the georeferenced locations of all survey data.</p> <p>6. Justification of its capability to accept and contain waste.</p>		

Table [ SEQ Table \\* ARABIC ]:Class VI Application Narrative: Supporting Data for Confining & Injection Zones

Information	CFR and Guidance	Location & File: GSDT or CBI?
<b>SUPPORTING DATA FOR CONFINING OR INJECTION ZONES (FULL SCALE)</b>		
<ol style="list-style-type: none"> <li>Uninterpreted copy of the base map, with all wells, etc. aka an AOR map, on the topo base would be helpful</li> <li>Well log data (when it is available), with injection and confining zones highlighted (if well logs are used for this demonstration)., porosity, permeability</li> </ol>		

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Information	CFR and Guidance	Location & File: GSDT or CBI?
<p>and both areal extent and lateral continuity of each.</p> <ul style="list-style-type: none"> <li>a. Provide a sufficient number of well logs to document the structural depths and thicknesses on the structure and isopach maps (may be referenced to an included set)</li> <li>b. Details on the any tests inc. porosity and permeability are discussed in the next section, Geomechanics &amp; Petrophysics.</li> </ul> <p>3. Location/area covered by seismic or other geophysical surveys</p> <ul style="list-style-type: none"> <li>a. Provide available geophysical characterization (seismic, gravity, magnetic &amp; EM) used to delineate and characterize the local structure:</li> <li>b. The source of the data and whether they are vintage or newly collected;</li> <li>c. The type of survey and other details of the deployment (e.g., date, location/areal extent of the survey, vendor who performed the survey);</li> <li>c. If boreholes were used, the locations of the boreholes;</li> <li>d. Type of data processing, including any reprocessing of vintage data; Images, with locations of profiles indicated on a map and salient geologic features identified (including formations below the injection zone where an injection depth waiver is sought);</li> <li>e. Assumptions and limitations associated with the method, data, and their interpretation;</li> <li>f. A narrative discussing the results in the context of the site geologic conceptual model; and</li> <li>g. If the data suggest non-unique interpretations, the owner or operator should address alternative interpretations. Show that the</li> </ul>	<p>Guidance: Structure 3.2; Geophysics 2.3.10</p>	

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Information	CFR and Guidance	Location & File: GSDT or CBI?
resolution of the data is sufficient for evaluation of the injection and confining zones		
7. Cross-Sections per Regional Geological Documentation		
a. At least minimal coverage: strike & dip intersecting well location(s)		
b. Log control (legible)		
c. All required USDW, horizons etc. added and labelled, including fault or fracture zones and salt structures		
d. Stratigraphic cross-sections include geologic age and datum, on which it is hung.		
8. Structural Maps per Regional Geological Documentation		
a. Key structures covered at effective scales (1" = 2000' or 1: - 500' for dense areas)		
b. Data sources clearly marked; depths TVD subsea; deviated well depth location identified; existing or planned cavern locations;		
c. Faults, shear zones, overhangs or any other geological feature, if identified or inferred, should be indicated on the structure map		
d. All information properly links: cross-sections and maps; faults show offset, seismic lines show same interpretation, etc.		

#### Site Characterization Cross-Discipline Narratives

Table [ SEQ Table \\* ARABIC ]: Faults and Fractures

Information	CFR and Guidance	Location & File: GSDT or CBI?
Faults and Fractures	40 CFR 146.82(a)(3)(ii); LAC §3607.C.1.b.iii	
1. Discuss known or suspected faults and fractures that may transect the confining or injection zones in the AoR		
a. Location and characteristics of the fault or fracture (e.g., geometry, depth, fault displacement, units juxtaposed by fault);	Guidance: 2.1, 2.2, and 2.3.2	

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Information	CFR and Guidance	Location & File: GSDT or CBI?
<ul style="list-style-type: none"> <li>b. Formations intersected or transected by the fault or fracture;</li> <li>c. Methods and results of fault stability analyses and comparison to preliminary anticipated (modeled) pressures during the injection phase of the project; and</li> <li>d. Information on faults and fractures in the lower confining zone (in cases where an injection depth waiver is sought).and a determination that they would not interfere with containment or on the commercial map.</li> </ul>		
2. Discuss evidence of fractures based on logs, formation age and nature, stress history or well test interpretations.		
3. Demonstrate the confining and injection zones are free of transecting, transmissive faults or fractures to prevent the vertical movement of fluids		
4. Evaluate fault geometry and stability (linked with geomechanics), fracture extension and the sealing capacity of faults or fractures <ul style="list-style-type: none"> <li>a. juxtaposing,</li> <li>b. mineralization,</li> <li>c. catalysis,</li> <li>d. shale gouge ratio,</li> <li>e. pressure compartmentalization</li> </ul>		
5. reference any figures or cross-sections demonstrating the geometry or forces.		
6. To demonstrate that a fault is not transmissive: <ul style="list-style-type: none"> <li>a. Describe the approach used to infer whether a fault or fracture is transmissive;</li> </ul>		

Information	CFR and Guidance	Location & File: GSDT or CBI?
<ul style="list-style-type: none"> <li>b. Summary table of data used to formulate the estimate;</li> <li>c. Supporting data and information (e.g., analyses of core samples, results of geophysical surveys, pore pressure data, maps, and cross sections) and any relevant calculations (e.g., calculation of shale gouge ratio); A narrative that describes and integrates the relevant information, including a discussion of any spatial heterogeneity in sealing properties and whether a fault or fracture is likely to be transmissive in the project area; and</li> <li>d. A discussion of uncertainties in the data.</li> </ul>		

Table [ SEQ Table \\* ARABIC ]: Geomechanical and Petrophysical Information

Information	CFR and Guidance	Location & File: GSDT or CBI?
Geomechanical and Petrophysical Information	40 CFR 146.82(a)(3)(iv); 40 CFR 146.87(b), required at 146.82(c)(7); 40 CFR 146.87(b) & (d), required at 146.82(c)(7);	
<ul style="list-style-type: none"> <li>1. Any special core tests would be covered in this section.</li> <li>2. For each analysis type (porosity, permeability and capillary pressure; fractures, ductility, rock strength, in-situ stress field (all 3 directions), pore pressure)</li> </ul>	LAC §3607.C.2.b (geomechanical) §3617.B.2 (whole or sidewall), required at §3619.A.7 (available logging info required by §3617.B)	
	Guidance: 2.3.5; 2.3.6; 4.1, 4.2 & 4.4	
<ul style="list-style-type: none"> <li>a. For field based data: <ul style="list-style-type: none"> <li>i. Date and time,</li> </ul> </li> </ul>		

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Information	CFR and Guidance	Location & File: GSDT or CBI?
<ul style="list-style-type: none"> <li>ii. location description: location map, area or depths (+formation) tested,</li> <li>iii. type of test (core, logging, test) with specific kind or method used,</li> <li>iv. data collection or test procedures,</li> <li>v. notes;</li> <li>b. Analysis Discussion: lab analysis or test methods, why selected, associated assumptions, condition of experiments or tests;</li> <li>c. Physical descriptions: <ul style="list-style-type: none"> <li>i. size and shape of grains and pores;</li> <li>i. any discontinuities in the samples or tests, e.g. fractures</li> </ul> </li> <li>d. Present results: calculations, data clean-up/corrections or other analysis steps; tabular, graphical or photographic results; summary statistics;</li> <li>e. Discuss results: include comparison across different tests (as appropriate), data quality or procurement issues, and uncertainty.</li> </ul>		
3. Geomechanical: Discuss fractures, stress, pressure, temperature, ductility, rock strength, rock/fluid compressibility and in situ fluid pressures within the confining zone, inc. details from log runs, tests, publications, borehole breakouts etc.		
4. Source of the Hydraulic gradients: tests, literature, pressure tests from which wells ...		
5. Provide fracture gradient calculations and maximum surface pressure limitation.		
6. 3D stress regime from calipers, borehole breakouts, publications, etc.		
<ul style="list-style-type: none"> <li>a. Type and location of the pressure gauge;</li> </ul>		

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Information	CFR and Guidance	Location & File: GSDT or CBI?
<ul style="list-style-type: none"> <li>b. Type of flow meter and calibration records;</li> <li>c. Raw pressure and flow data;</li> <li>d. Plot of flow rate versus pressure data; and</li> <li>e. Discussion of any anomalous data.</li> </ul> <p>4) Include support documentation to verify the reservoir temperature selection, i.e., a plot of the recorded temperatures versus depth from area well logs, temperature surveys, etc.</p> <p>7. Log interpretation electronic report by a log analyst:</p> <ul style="list-style-type: none"> <li>a. discuss logs adequately and correctly characterize all formations and the analyst is knowledgeable</li> <li>b. The date and time of each test, the date of well bore completion, and the date of installation of all casings and cements;</li> <li>c. Chart results of each log and any supplemental data;</li> <li>d. The name of the logging company and log analyst and information on their qualifications;</li> <li>e. Interpretation of the well logs by the log analyst, including any assumptions, determination of porosity, permeability, lithology, thickness, depth, and formation fluid salinity of relevant geologic formations; and</li> <li>f. Any changes in interpretation of site stratigraphy based on formation testing logs. 6) If the log analysis and other data differs discuss the implications for any of the planned operational procedures, the AoR determination, or the GS project plans.</li> </ul>		

Table [ SEQ Table \\* ARABIC ]: Zonal Hydrologic Properties

Information	CFR and Guidance	Location & File: GSDT or CBI?
Zonal Hydrologic Properties		
<ol style="list-style-type: none"> <li>1. Hydrologic properties of the injection or confining zone; <ol style="list-style-type: none"> <li>a. Fall Off tests: <ol style="list-style-type: none"> <li>i. Raw pressure data;</li> <li>ii. Flow data from the injection portion of the test;</li> <li>iii. Test parameters (injection time, shut-in time, fluid viscosity, temperature, well bore diameter, pressure gauge type and location);</li> <li>iv. Semi-log plots used for data analysis;</li> <li>v. Parameters calculated from the analysis; and</li> <li>vi. Discussion of the results, including data quality and any anomalous values.</li> </ol> </li> <li>b. Injectivity or Pump Tests: <ol style="list-style-type: none"> <li>i. Raw pressure data;</li> <li>ii. Flow data including rates and times;</li> </ol> </li> <li>c. Test parameters <ol style="list-style-type: none"> <li>i. injection time,</li> <li>ii. fluid viscosity,</li> <li>iii. temperature,</li> <li>iv. well bore diameter,</li> <li>v. pressure gauge type and</li> <li>vi. location</li> </ol> </li> </ol> </li> </ol>		

Information	CFR and Guidance	Location & File: GSDT or CBI?
d. Semi-log plots used for data analysis;		
i. Parameters calculated from the analysis; and		
ii. A discussion of the results, including data quality and any anomalous values.		

Table [ SEQ Table \\* ARABIC ]: Geochemistry

Information	CFR and Guidance	Location & File: GSDT or CBI?
Geochemistry	40 CFR 146.82(a)(6); 40 CFR 146.82(c)(3); 40 CFR 146.87(c), required at 146.82(c)(7); & 40 CFR 146.87(c)(3)	
1. Describe the geochemical conditions (baseline formation water chemistry:	LAC §3607.C.2.e	
a. balanced ions/cations; trace elements, temperature, SC, and pressure when sampled);	Guidance: 2.3.4 and 2.3.9; 3.3; 4.3	
a. all water-bearing formations in or potentially in a USDW; confining or injection zones;		
b. Source of Data;		
c. dates, locations (map), formations, depths, etc;		
d. sample and preservation methods;		
e. analytical methods;		
f. QA used;		
g. discuss tabulate and graph results (AoR map, piper or stiff diagrams), anomalies and spatial representativeness for each formation		
2. Fluid Samples:		

Information	CFR and Guidance	Location & File: GSDT or CBI?
<ol style="list-style-type: none"> <li>a. Type of sampling equipment used and field procedures (e.g., sample preservation);</li> <li>b. If the sample was pumped, flow rate, type of pump, and location of the pump, and geochemical modeling results indicating the likely geochemical makeup of the fluids at downhole conditions;</li> <li>c. Data for field measurements (pH, SC, temperature, pressure);</li> <li>d. Laboratory results, including QA samples (e.g., blanks, duplicates, matrix spikes); and</li> <li>e. Notes on any anomalous data.</li> </ol> <ol style="list-style-type: none"> <li>2. Describe solids or fluids present that may affect storage, confinement, or project performance especially any interaction with the proposed injection stream; (from cuttings or cores) and the methods used in determining them.               <ol style="list-style-type: none"> <li>a. Will any minerals dissolve in low pH conditions?</li> <li>b. Extrapolate test results for supercritical CO<sub>2</sub> as the non-wetting fluid.</li> </ol> </li> <li>3. Describe the chemistry of the planned injection stream.</li> <li>4. Discuss the compatibility of the injected waste with the injection zone fluids and solids: include potential interactions that could affect injectivity or mobilize trace elements - especially required if high concentrations of trace elements exist</li> <li>5. Demonstrate if the waste will adversely alter the confining capabilities of the injection and confining zones:               <ol style="list-style-type: none"> <li>a. elements that may alter the gas compressibility; and</li> <li>b. identify potential chemical reactions that could mobilize contaminants and potentially</li> </ol> </li> </ol>		

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Information	CFR and Guidance	Location & File: GSDT or CBI?
endanger USDWs. (these should be modeled)		
6. Discuss compatibility with well construction: piping, cement and packers or test equipment.		

Table [ SEQ Table \\* ARABIC ]: Other Information (Including Surface Air and/or Soil Gas Data, if Applicable)

Information	CFR and Guidance	Location & File: GSDT or CBI?
Other Information (Including Surface Air and/or Soil Gas Data, if Applicable)	40 CFR 146.90(h); LAC §3607.C.2.d, §3625.A.8 Guidance: 2.3.11	
1. Discuss any baseline readings and variability of CO2 or parameters planned for tracking the plume front.		
a. Demonstrate that the locations sampled represent a reasonable grid size and that potential point sources are represented and will serve as a good baseline;		
b. Demonstrate that seasonal and diurnal variations in carbon dioxide levels have been captured and describe the variability in the data for future reference;		
c. Site characteristics: soil type, soil organic carbon content, vegetation type and density, topography, surface water hydrology;		
d. Sampling locations (in map form) and dates;		
e. Soil temperature and moisture data and atmospheric conditions;		
f. Sampling and analytical methods, including detection limits;		
g. Results presented as concentrations and fluxes in tabular and graphic form, including QA samples and analyses;		
h. Methods and results of regression analyses; and		

- i. Methods and results of any ecological modeling performed, including input data, outputs, and sensitivity analyses.
- 2. Well logs should
  - a. Be legible with the headers and repeat section included.
  - a. Have the relevant sections labelled or highlighted (injection or confining zones, USDW, cores depths, test intervals, ...)

Table [ SEQ Table \\* ARABIC ]: Site Suitability Narrative

Information	Location & File: GSDT or CBI?
<b>Site Suitability:</b> 40 CFR 146.82(c)(2); 40 CFR 146.83 LAC §3619.A.2; §3615.A	
1. Briefly summarize why the geologic setting is suitable for a sequestration project: such as <ul style="list-style-type: none"> <li>a. The basic geometry (structural or stratigraphic trap), confinement and lack of potential leakage pathways;</li> <li>b. Facies changes in the subsurface and how this feeds the conceptual model. Characterize permeability and capillary pressure to evaluate movement through the confining zone; The implications for connectivity within the injection formation and the suitability of the confining zone;               <ul style="list-style-type: none"> <li>i. Lithofacies distributions mapped in the injection and confining formations, including the distributions of properties such as porosity and permeability for each lithofacies;</li> <li>ii. The potential for preferential flow paths;</li> <li>iii. Diagenetic processes that may affect present-day hydrogeologic properties; and</li> <li>iv. Uncertainties associated with the data and with the resulting facies model.</li> </ul> </li> </ul>	
2. Justification of storage capacity: <ul style="list-style-type: none"> <li>a. Discuss the capacity versus the planned storage inc. the approach used based on the site-specific information.</li> </ul>	

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Information	Location & File: GSDT or CBI?
<ul style="list-style-type: none"> <li>i. A description of the selected estimation method, including a discussion of its suitability for the type of formation;</li> <li>ii. Tabulation of any input data used, along with estimates of uncertainty in those data;</li> <li>iii. Results in tabular or graphic format;</li> <li>iv. A discussion of the results, relating them to proposed operational parameters and the anticipated total volume of carbon dioxide to be injected and the duration of the project and any identified site-specific vulnerabilities (e.g., faults, fractures, etc.)</li> <li>b. Discuss assumptions and limitations of the method used;</li> <li>c. Discuss uncertainty based on the results of a sensitivity analysis; and</li> <li>d. Discuss how the results are consistent with and/or supported by the AoR delineation modeling</li> </ul>	
<p>3. Justification of confinement:</p> <ul style="list-style-type: none"> <li>a. Describe how the (specific) data was collected and how it demonstrates the confining zone will not allow migration of carbon dioxide outside the intended injection zone(s) and that the site meets the requirements at 40 CFR 146.83(a)(2);</li> <li>b. Discuss all lines of evidence; <ul style="list-style-type: none"> <li>i. details of any calculations;</li> <li>ii. supportive images or illustrations;</li> <li>iii. Potential errors and the possible effect on the evaluation;</li> <li>iv. incl. data uncertainty and spatial heterogeneity</li> </ul> </li> </ul>	
<p>4. Is a secondary confining zone required?</p> <ul style="list-style-type: none"> <li>a. Demonstrate that a secondary confinement exists to <ul style="list-style-type: none"> <li>i. Ensure USDW protection,</li> <li>ii. Impede vertical fluid movement,</li> <li>iii. Allow for pressure dissipation, and</li> </ul> </li> </ul>	

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**Information****Location & File:  
GSDT or CBI?**

- iv. Provide additional opportunities for monitoring, mitigation and remediation.

**5. Reference the map showing**

- a. All boundaries (state, tribe or territory);
- b. Archeological or cultural sites;
- c. Military installations,
- d. Threatened or endangered species
- e. Surface features:
  - i. Water bodies (surface, seasonal & springs; impoundments, floodplains, spillways),
  - ii. All existing infrastructure (surface and subsurface mines or quarries; any structure for human occupancy),
  - iii. Plus, the surface trace of known or suspected faults.
- f. Any State or Federal subsurface cleanup sites.
- g. Well locations include all classes of injection, production, use or status. (These are primarily covered in the AoR)

**6. CO2 stream compatibility with the well and subsurface formations and fluids. show that the well will not be damaged by the injectate and that no geochemical reactions within the injection and/or confining formations will affect the storage and/or containment.**

- a. Geochemical model
  - i. The model used;
  - ii. Input data in tabular form;
  - iii. Modeling parameters and data used (e.g., activity coefficient model, identification of thermodynamic database, solid phases selected, reactions modeled, kinetic data, etc.);
  - iv. Results in tabular and graphical form;
  - v. Narrative interpreting the results and their applicability to the project; and
  - vi. Discuss limitations and uncertainties associated with the modeling.
- b. Experiments:

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Information	Location & File: GSDT or CBI?
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- i. Describe experimental method;
  - ii. Describe composition and origin of solids used;
  - iii. Chemistry of the input solution and the carbon dioxide phase (i.e., impurities);
  - iv. Porosity and permeability of the rock sample prior to experimentation;
  - v. Plots of solution chemistry with time during the experiment;
  - vi. Geochemical reactions (e.g., dissolution and precipitation of minerals) that have taken place;
  - vii. Methods of evaluating permeability and porosity at the end of the experiment and the resulting values; and
  - viii. Narrative discussing the results and their implication for long-term behavior of the site, including changes in injectivity, the degree of mineral trapping, and how this information relates to the AoR delineation.
- c. Well material compatibility
- i. Describe experimental methods;
  - ii. Why the particular experimental technique was chosen;
  - iii. Conditions under which the cement sample was cured;
  - iv. The chemistry of the input solution and the carbon dioxide phase (i.e., impurities);
  - v. Porosity, permeability, and density of the cement sample prior to experimentation;
  - vi. Plots of solution chemistry with time during the experiment;
  - vii. Properties of the cement sample at the end of the experiment and at any intermediate stages at which samples are taken; and
  - viii. Discuss results and implications for the long-term integrity of the cement.
- d. Modeling
- i. The model used;
  - ii. Input data in tabular form;

Information	Location & File: GSDT or CBI?
<ul style="list-style-type: none"> <li>iii. Modeling parameters and data used (activity coefficient model, thermodynamic database, solid phases selected, reactions modeled, kinetics data, etc.);</li> <li>iv. Results in tabular and graphical form;</li> <li>v. Narrative interpreting the results and their applicability to the project; and</li> <li>vi. Discuss limitations and uncertainties associated with the modeling.</li> </ul>	

DRAFT

Environmental Justice (EJ)  
40 CFR 25

59 FR 7269, February 16, 1994  
Pg 45

K. Involving the Public in Permitting Decisions

'Public input and participation in GS projects has a number of benefits, including:

- (1) Providing citizens with access to decision-making processes that may affect them;
  - (2) educating the community about a GS project;
  - (3) ensuring that the public receives adequate information about the proposed GS project;
- and
- (4) allowing the permitting authority and owners or operators to become aware of public viewpoints, preferences and environmental justice concerns and ensuring these concerns are considered by decision-making officials.'

'Nearly all commenters agreed that early and frequent public education and participation would enhance public acceptance of GS projects. ... EPA encourages owners or operators and permitting agencies to involve the public by providing them information about the Class VI permit

(and any requests for a waiver of the injection depth requirements or an expansion of the areal extent of an aquifer exemption) as early in the process as possible'

Pg 57

J. Executive Order 12898: Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations

... 'EPA has determined that this final rule will not have disproportionately high and adverse human health or environmental effects on minority or low-income populations because it increases the level of environmental protection for all affected populations. Existing electric power generation plants that burn fossil fuels may be more prevalent in areas with higher percentages of people who are minorities or have lower incomes on average, but it is hard to predict where new plants with CCS will be built.' ... (see Geologic Sequestration of Carbon Dioxide – UIC Quick Reference Guide)

40 CFR §124.10 Public notice of permit actions and public comment period.

(2)(c)(1)(xi)

For Class VI injection well UIC permits, mailing or e-mailing a notice to State and local oil and gas regulatory agencies and State agencies regulating mineral exploration and recovery, the Director of the Public Water Supply Supervision program in the State, and all agencies that oversee injection wells in the State.

1. Review demographics for EJ communities
  - a. Will siting the proposed Class VI well at the proposed location exacerbate any existing disproportionate impacts to minority and low-income communities within the delineated AoR?
  - b. Will there be any environmental or health impacts on minority and low-income communities from the siting of the proposed Class VI injection well with respect to exposure and susceptibility to potential environmental hazards?
  - c. What is the likely distribution of any environmental and public health benefits from the proposed Class VI well in communities within the delineated AoR?
  - d. Are there maps or other tools available that may assist with communicating with, and soliciting input from, identified communities about the proposed GS project and Class VI permit?
  - e. If minority and low-income communities might be affected by the proposed Class VI injection well, can the UIC Program Director or owner or operator undertake any potential mitigation measures to improve community security and acceptance of the proposal?
2. Develop outreach materials for public participation.
3. List of existing environmental hazards, potential exposure pathways, susceptible sub-populations
4. Permitting Authority generates a demographic profile of area, but the applicant is advised to also do so.
  - a. EJView now replaced by [ HYPERLINK "https://www.epa.gov/ejscreen" ]



## GSDT Initial Permit Application Fields

Table [ SEQ Table \\* ARABIC ]: Project Narrative Submission Panel

GSDT Entry	Information	CFR and Guidance	Included: GSDT or CBI?
Confirm submission: permit application components	<ol style="list-style-type: none"> <li>Proposed project plans submitted under PP Modules <ol style="list-style-type: none"> <li>Area of Review (AoR) and Corrective Action Plan</li> <li>Testing and Monitoring Plan</li> <li>Well Plugging Plan</li> <li>Post-Injection Site Care (PISC) and Site Closure Plan</li> <li>Emergency and Remedial Response Plan</li> </ol> </li> <li>Computational modeling information (Narrative in AoR)</li> <li>Financial responsibility demonstration</li> <li>Proposed Pre-Operational logging and testing program</li> <li>Optional Alternative PISC demonstration</li> </ol>		
Optional, Supplemental Items	<ol style="list-style-type: none"> <li>Injection depth waiver application</li> <li>Aquifer exemption expansion request</li> </ol>		
Other Information uploaded or info required by primacy state	<ol style="list-style-type: none"> <li>If desired, appendices, attachments, or other supplemental information associated with the narrative that do not fit into one of the specific GSDT modules can be uploaded here.</li> </ol>		

Table [ SEQ Table \\* ARABIC ]: Updated Information (tab)

GSDT Entry	Information	CFR and Guidance	Later Phase
Pre-operation narrative	<ol style="list-style-type: none"> <li>1. Narrative describing updated site characterization information, synthesizing the results of pre-operational logging and testing, and other general project information (compiled into a single file and submitted using the Project Information Tracking module of the GSDT).</li> <li>2. Final AoR Model Delineation <ol style="list-style-type: none"> <li>a. short description of the information and files submitted to the GSDT related to the final AoR model and delineation that incorporates the results of pre-operational testing and logging, with references to the rule requirements those submissions satisfy.</li> <li>b. If there is additional information that could not be submitted using the forms in the GSDT, it can be included here.</li> <li>c. How well do site-specific pre-operational testing and logging results compare to the data used in the original permit application? What are the differences between the original and updated site characterization?</li> <li>d. What specific testing and logging results led to updates in the site characterization?</li> <li>e. How well do pre-operational testing and logging results compare to literature and regional geologic and hydrogeologic data? What are the possible reasons for the differences?</li> <li>f. How do the data collected as part of pre-operational testing and logging inform a comprehensive understanding of site-specific conditions? Are any additional testing and monitoring methods required to gain a greater understanding?</li> </ol> </li> <li>3. Any other headings with updated or synthesized information. (per check boxes in GSDT)</li> </ol>	<p>40 CFR 146.82(a)(1) &amp; (c)(1)</p> <p>LAC §3607.B &amp; §3619.A.1</p>	
New or Updated submissions	<ol style="list-style-type: none"> <li>1. Final AoR delineation and final corrective action status; in none required include justification in narrative file</li> <li>2. Results of formation testing and logging (required for all projects) <ol style="list-style-type: none"> <li>a. AoR and Corrective Action Plan</li> </ol> </li> </ol>		

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GSDT Entry	Information	CFR and Guidance	Later Phase
	<ul style="list-style-type: none"> <li>b. Testing and Monitoring Plan</li> <li>c. Well Plugging Plan</li> <li>d. PISC and Site Closure Plan</li> <li>e. Emergency and Remedial Response Plan</li> </ul>		
Any updates in these modules	<ul style="list-style-type: none"> <li>1. Financial responsibility demonstration</li> <li>2. Updated Alternative PISC demonstration</li> <li>3. Updated Injection depth waiver application</li> <li>4. Updated Aquifer exemption expansion request</li> </ul>		
Other Updated Information uploaded or info required by primacy state	<ul style="list-style-type: none"> <li>1. File names with descriptive headers please</li> </ul>		

Table [ SEQ Table \\* ARABIC ]: Complete Submission (tab)

GSDT Entry	Information	CFR and Guidance	Later Phase
Validate Required Fields	<ul style="list-style-type: none"> <li>1. Required check for blank fields</li> </ul>		
Authorized submission	<ul style="list-style-type: none"> <li>1. Must have completed an EPA Electronic Signature Agreement</li> <li>2. Submit means you agree to the certification.</li> </ul>		